

Mosquito Control and Exposure to Pesticides

Virginia and North Carolina, 2003

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Centers for Disease Control and Prevention (CDC)



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Background

Albemarle Regional Health Services

 Environmental 
Health Service

Vector Management Office

and

Mosquito Laboratory

Hurricane Isabel



September 18, 2003, at 7:53 a.m.



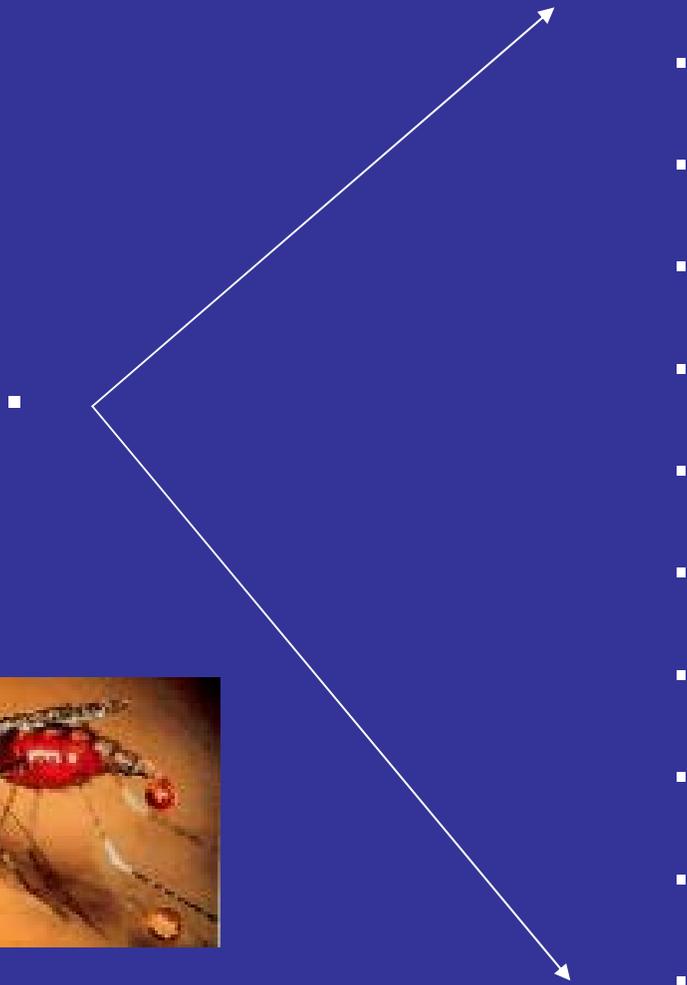
Rain and Flooding in Virginia and North Carolina



Rainfall 4-12 inches
Tide levels 6-8 ft above normal



Expected Increased in Mosquito Populations 500% to 1000%



Arbovirus Reservoirs Identified

1. Eastern Equine Encephalitis
2. West Nile Virus

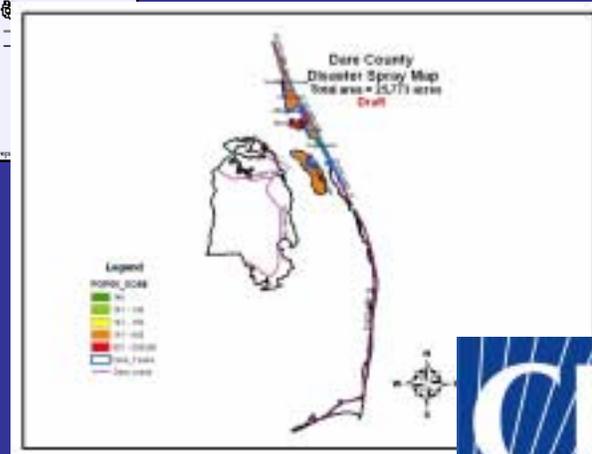
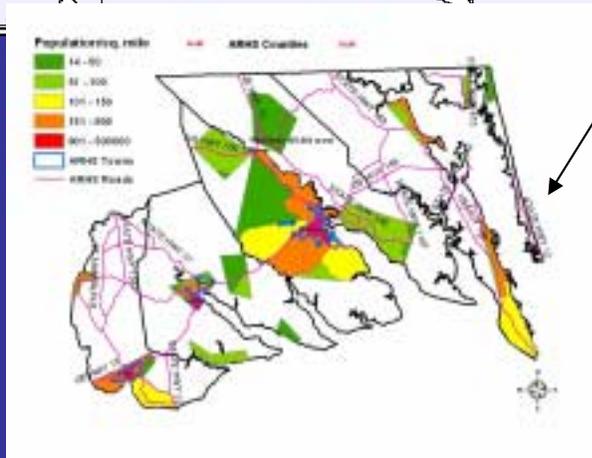
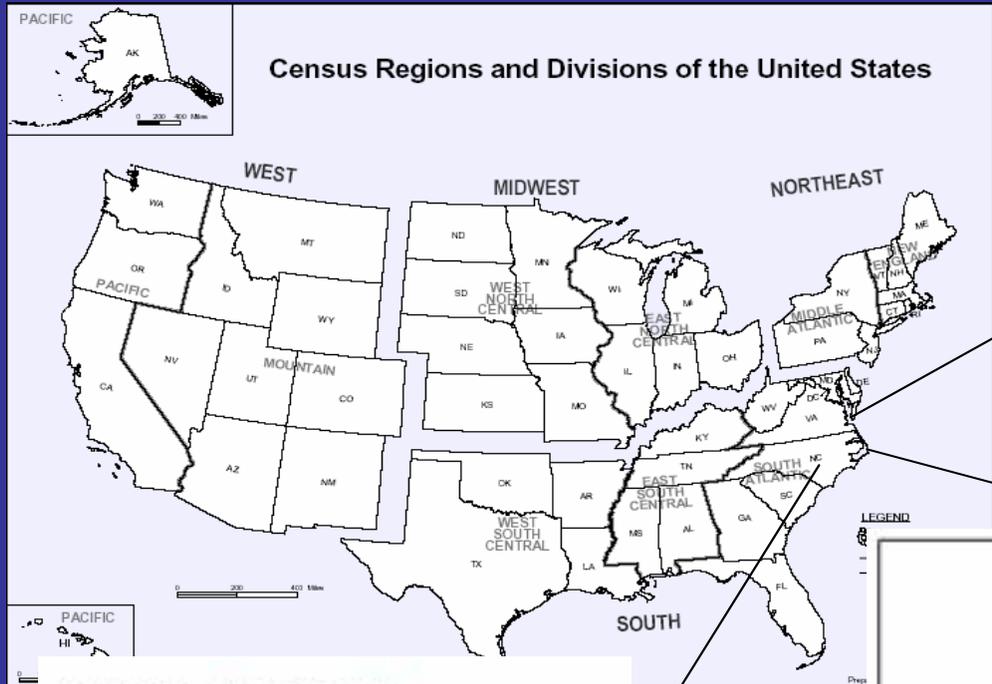


Virginia and North Carolina Public Health Responses

1. Continue truck-mounted spraying with mosquito adulticide (permethrin/d-phenothrin)
2. Request aerial spraying with mosquito adulticide (naled)
3. Invite CDC to assess human pesticide exposure



Location of Study



Evidence-Based Public Health

1. Little data on non-occupational pesticide exposure in humans during mosquito control efforts
2. Naled (Dibrom®) studies limited:
 - Environmental Sampling
 - Chronic Occupational Exposure



Objective

1. Quantify human exposure from aerial ultra-low volume (ULV) spraying with naled (Dibrom®)
2. Quantify human exposure to surface ULV spraying
 - North Carolina: permethrin (Biomist30+30®)
 - Virginia: d-phenothrin (Anvil 10+10®)



Methods



Study Design

1. Compare urine pesticide metabolite levels before and after spraying to determine if spraying caused an overall increase in exposure for this population:
 - Number of participants with increases in urine pesticide metabolite levels after spraying
- With
- Number of participants with decreases in urine pesticide metabolite levels after spraying



Study Design

2. Control for household and workplace exposure by comparing:

- Urine pesticide metabolite levels

With

- Responses exposure questionnaires



2003 Timeline

- 9/18 Hurricane Isabel
- 9/22-25 Invitation to the North Carolina and Virginia
- 9/27-29 Prespray urine samples obtained and exposure questionnaires administered
- 9/29-30 Aerial spraying (surface spraying continues)
- 9/29-10/1 Postspray urine samples obtained and exposure questionnaires administered
- 12/9 Laboratory analysis completed



September 27-29, Recruitment of Participants

1. Randomly selected 8 clusters of 4 census blocks from areas to be sprayed by airplanes
2. Systematically went door to door to recruit 6 participants per census block
3. Recruited one adult and/or one child between 7-18 years per household



September 27-29, Assessing Baseline Pesticide Exposure

1. Administered questionnaire about a history of common pesticide exposure:
 - Household
 - Work
2. Obtained a prespray urine sample to quantify baseline pesticide metabolite levels



September 9/29-30, Aerial Spraying with Ultra Low Volumes of Naled (Dibrom®)

Virginia 9/29/03

- 0.5 ounces per acre
- Altitude of 150 feet
- Wind speed < 10 knots
- 4-7 PM

North Carolina 9/30/03

- 0.7 ounces per acre
- Altitude of 150 feet
- Wind speed 2 knots
- 6-8 PM



September 9/29-30, Surface Spraying with ULV Permethrin and d-Phenothrin

North Carolina

- Permethrin
(Biomist 30+30®)
- Concentration of
0.0014 lbs/acre
- 6-11PM

Virginia

- D-Phenothrin
(Anvil 10+10®)
- Concentration of
0.0036 lbs/acre
- 6-9Pm



September 29-October 1, Assessing Postspray Pesticide Exposure

1. Administered questionnaire about history of common pesticide exposure:
 - Household
 - Work
 - Aerial and surface spraying
2. Obtained a postspray urine to quantify changes in pesticide metabolite levels



October-December

Division of Laboratory Sciences

National Center for Environmental Health

Lyophilization with gas chromatography-tandem mass spectrometry and isotope dilution quantification:

- 6 organophosphorus metabolites
- 5 pyrethroid metabolites



Six organophosphorus metabolites tested

1. Dimethylphosphate (DMP)
2. Dimethylthiophosphate (DMTP)
3. Dimethildithiophosphate (DMDTP)
4. Diethylphosphate (DEP)
5. Diethylthiophosphate (DETP)
6. Diethildithiophosphate (DEDTP)



Six organophosphorus metabolites tested

1. **Dimethylphosphate** → **non-specific named metabolite**
2. Dimethylthiophosphate
3. Dimethyldithiophosphate
4. Diethylphosphate
5. Diethylthiophosphate
6. Diethyldithiophosphate



Five pyrethroid metabolites tested

1. 3-phenoxybenzoic acid (3pba)
2. 4-fluoro-3-phenoxybenzoic acid (4f3pba)
3. cis-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane-carboxylic acid (cis-dcca)
4. trans-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane-carboxylic acid (transdcca)
5. cis-3-(2,2-dibromo-vinyl)-2,2-dimethylcyclo-propanecarboxylic acid (dbca)



Five pyrethroid metabolites tested

1. **3-phenoxybenzoic acid** → **nonspecific permethrin/d-phenothrin metabolite**
2. 4-fluoro-3-phenoxybenzoic acid
3. cis-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane-carboxylic acid
4. trans-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane-carboxylic acid
5. cis-3-(2,2-dibromo-vinyl)-2,2-dimethylcyclo-propanecarboxylic acid



Statistical Analysis General Estimating Equations

1. Data clustered within each household
2. Non-normal distribution
3. Data not symmetric



Results

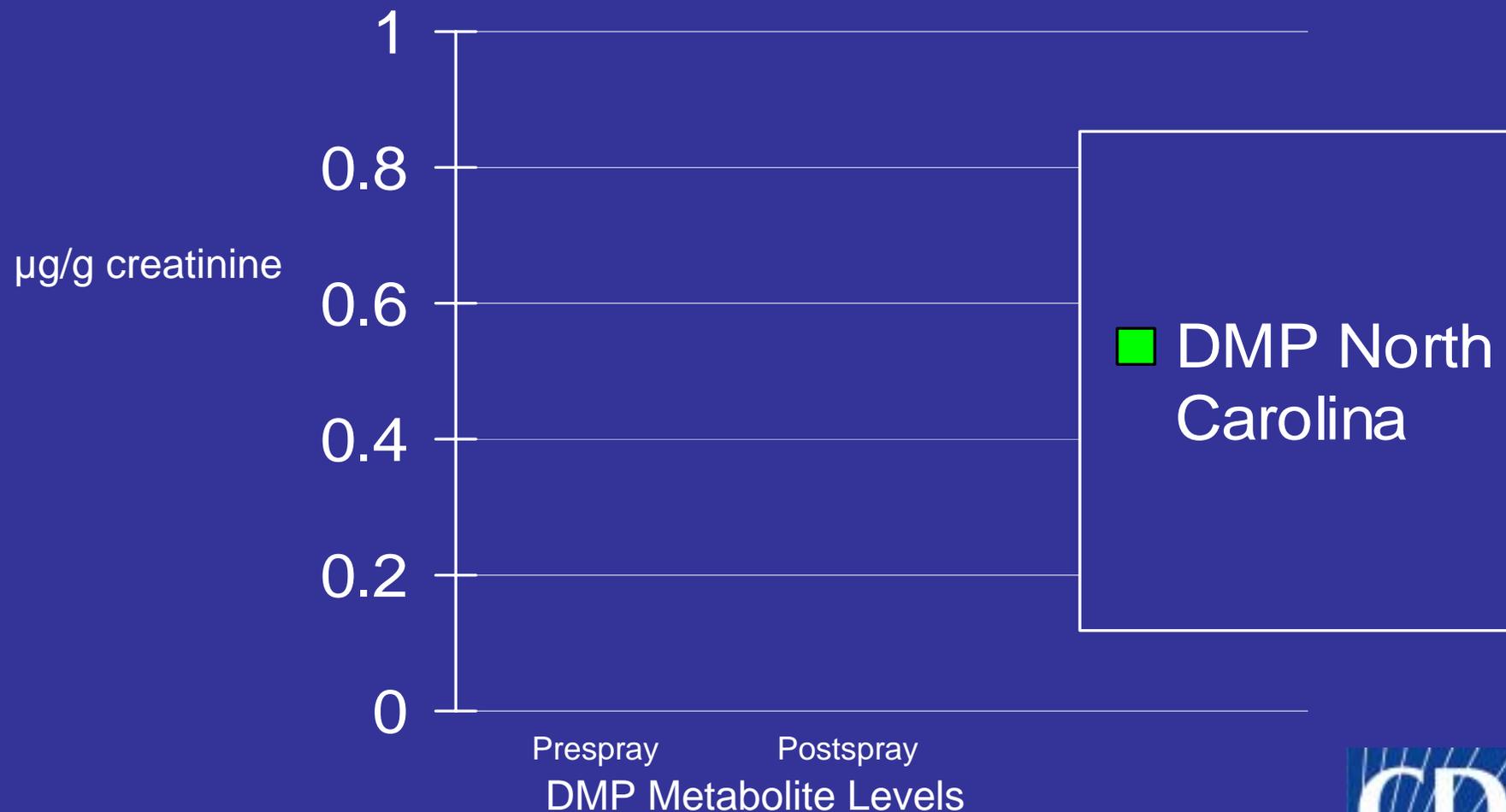


Completion Rate

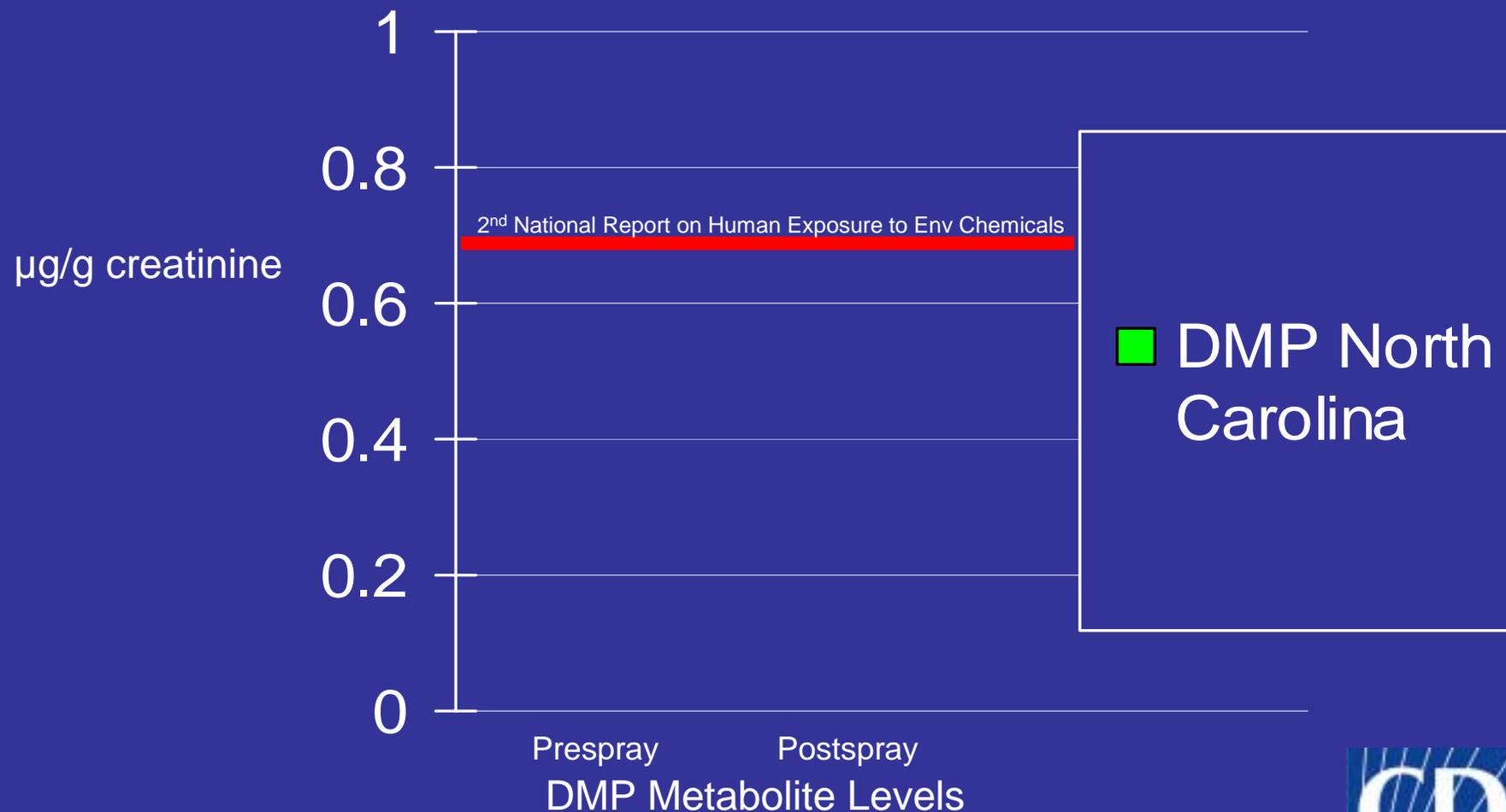
- Virginia
 - 84 (88%) of 95 provided postspray urine and exposure questionnaires
- North Carolina
 - 74 (82%) out of 90 provided postspray urine and exposure questionnaires



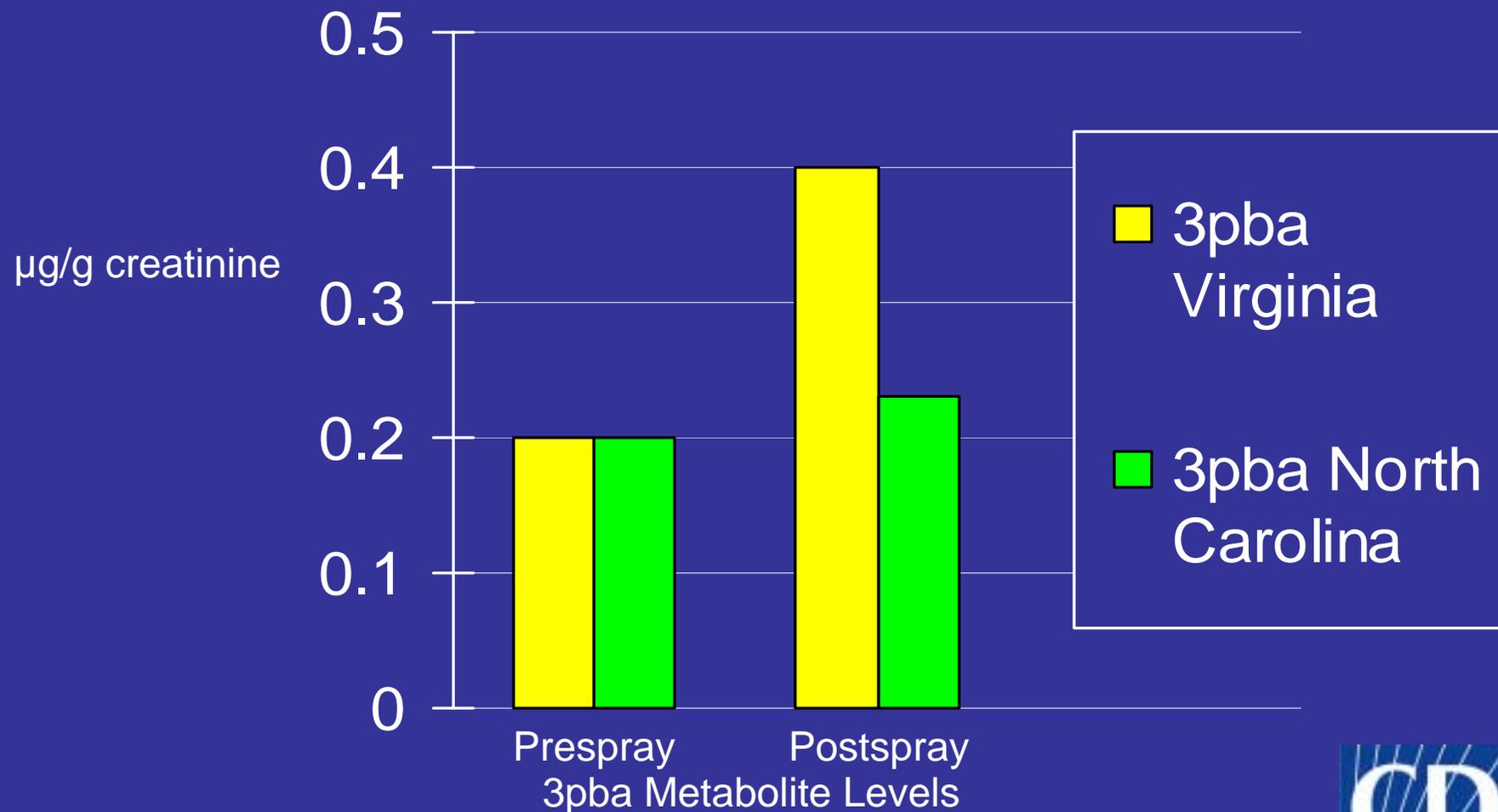
Median DMP Levels for North Carolina and Virginia, 2003



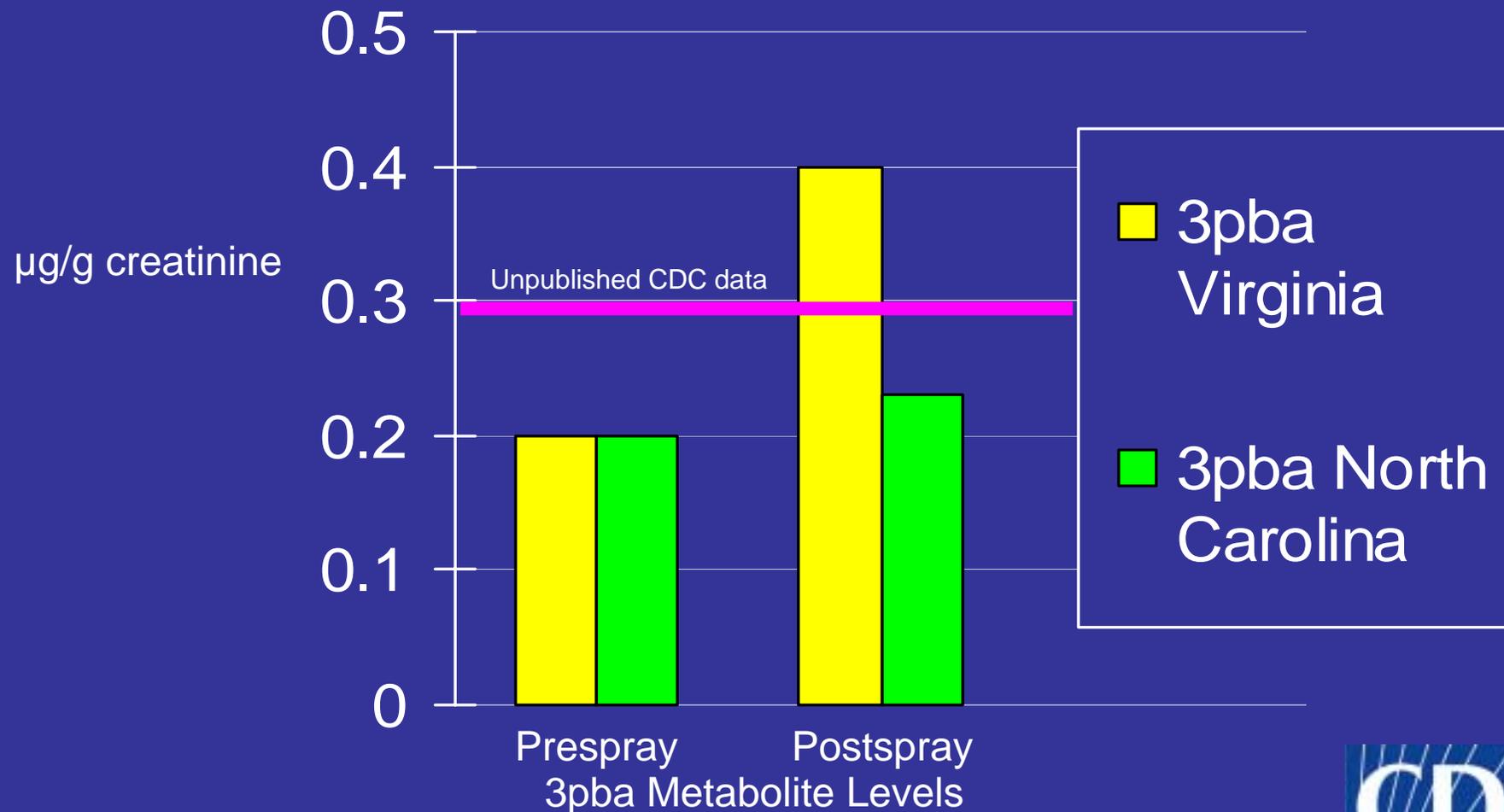
Median DMP Levels for North Carolina and Virginia, 2003



Median 3pba Levels for North Carolina and Virginia, 2003



Median 3pba Levels for North Carolina and Virginia, 2003



Analysis

1. Compare:

Number of participants with increases in urine pesticide metabolite levels after spraying

Number of participants with decreases in urine pesticide metabolite levels after spraying

2. Examine:

Urine pesticide metabolite levels

Responses in the household and workplace exposure questionnaires



Results of Exposure to Aerial Spraying with ULV of Naled

No statistically significant difference (NC $p=0.47$, VA $p=0.22$) between:

- number of people with increases in the concentration of the naled metabolite (dimethylphosphate), NC $n=21$ VA $n=30$
- number of people with decreases in the concentration of the naled metabolite (dimethylphosphate), NC $n=29$ VA $n=21$



Results of Exposure to Surface Spraying with ULV of Permethrin/d-Phenothrin

No statistically significant difference (NC $p=0.50$, VA $p=0.51$) in areas sprayed by trucks and airplanes concurrently:

- number of people with increases in the concentration of the permethrin/d-phenothrin metabolite (3pba) NC $n=7$ VA $n=23$
- number of people with decreases in the concentration of the permethrin/d-phenothrin metabolite (3pba) NC $n=10$ VA $n=19$



Results of Exposure Questionnaires and Urine Pesticide Metabolite Levels

1. No statistically significant association with levels of metabolites and reports of:
 - Staying indoors
 - Closing windows during spraying
 - Using air conditioning

Results of Exposure Questionnaires and Urine Pesticide Metabolite Levels

2. Statistically significant association with level of metabolites and reports of work in greenhouses or plant nurseries ($p < 0.0001$)

Yes: $n=2$

dimethyldithiophosphate geometric mean = $9.54 \mu\text{g/g}$ of creatinine

No: $n= 79$

dimethyldithiophosphate geometric mean = $0.92 \mu\text{g/g}$ of creatinine)



Strengths

1. Prospective study design allows for accurate assessment of a baseline prior to determining exposure
2. Innovative laboratory techniques used are extremely sensitive and accurate
3. Addresses large non-occupational population exposure



Limitations

1. Analysis of subpopulations in questionnaires is unstable due to small sample size
2. Study may have altered participant's pesticide use and avoidance patterns
3. Did not verify exposure



Conclusions

1. Aerial spraying with ULV naled at a concentration < 0.7 ounces per acre was not associated with an increase in the dimethylphosphate urine levels of participants



Conclusions

2. Truck mounted spraying with permethrin 0.0015 lbs/acre or d-phenothrin at 0.0625 lbs/acre was not associated with the urine 3pba levels



Conclusions

3. Household and occupational exposure to pesticides may be significant and warrants further investigation



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